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BIOLOGICAL EVALUATION OF INSECT DAMAGE AT THE
ERAMBERT SEED ORCHARD, NATIONAL FORESTS IN MISSISSIPPI (1983)

by

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Abstract

A seed orchard scouting program consisting of 5 visits was conducted during the 1983 growing season at the Erambert Seed Orchard, Brooklyn, Mississippi. Approximately 1,460 bushels of the 1983 loblolly cone crop were predicted to be present in the Alabama loblolly seed source as of September 1983. This estimate represents the survival of 64% of the 1983 crop from March 1982 to September 1983. Approximately 69% of the 1984 crop survived from March 1983 to September 1983. Insects were the major identifiable agents causing losses to both crops. Forest Pest Management (FPM) recommends that the 1984 pest management strategy for loblolly, slash, longleaf, and shortleaf seed sources should consist of a spray schedule using Pydrin® and Guthion®.

INTRODUCTION

A seed orchard scouting program was initiated during 1982. This scouting program was designed to:

- 1) quantify the losses attributed to the major mortality agents
- 2) determine the periods when major mortality occurs
- 3) determine the effect these losses will have on the projected cone crop
- 4) identify areas where modifications could be made to the current pest management strategy to better respond to pest pressures.

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A scouting crew from Forest Pest Management (FPM), Alexandria Field Office, monitored damage incidences and pest populations during the 1982 and 1983 growing seasons. During these visits data were compiled confirming that insects are the major identifiable agents causing losses in seed orchards (Overgaard et al. 1974) and, if not controlled, insect pests will adversely affect the availability of superior pine seed, thereby reducing future timber production (Barber 1982). Because there continues to be a demand for loblolly, slash, and longleaf seed, personnel from the National Forests of Mississippi are interested in maximizing seed production. Based upon the results of these evaluations, Forest Pest Management recommends significant changes to the current pest management strategy.

METHODS OF EVALUATING INSECT POPULATIONS AND LOSSES

Pest management decisions are dependent upon accurate predictions and assessments of crop production levels (I), pest population levels (II), and associated damage levels (III). Three inventory-monitoring systems were implemented to quantify this information.

I. Assessment of Crop Production Levels

A. Selection of sample trees for inventory-monitoring system (Bramlett and Godbee 1982)

Sixteen clones of the Alabama loblolly seed source were selected as inventory clones. Eight clones were selected from the high production class, 5 clones were selected from the medium production class, and 3 clones were selected from the low production class. Three ramets were sampled from each of the inventory clones. Table 1 lists the selected clones, the number of ramets sampled, and the number of ramets of each clone within the Alabama loblolly seed source.

Samples were taken from ramets of 80% of the high producing clones, 55% of the medium producing clones, and 10% of the low producing clones.

B. Inventory procedures

The upper and lower crown of each sample tree was divided into quadrants. The average number of flowers per cluster for each of the 8 areas of the crown was obtained by counting the number of flowers in 4 clusters located within each area and dividing by 4. Prior to conelet closure, all of the candles bearing flower clusters within each area of the tree crown were estimated. This number was multiplied by the average number of flowers per cluster and entered on the data sheet as a total tree count.

Table 1. Clones and the number of ramets sampled in each production class.

Clone	Production Classes					
	High		Medium		Low	
	No. Ramets (Sampled)	No. Ramets (Orchard)	No. Ramets (Sampled)	No. Ramets (Orchard)	No. Ramets (Sampled)	No. Ramets (Orchard)
6			3	74		
8	3	88				
9	3	42				
11			3	65		
16					3	59
17					3	38
21			3	53		
25					3	63
27			3	54		
34	3	58				
39	3	43				
45			3	76		
47	3	82				
48	3	41				
49	3	92				
50	3	56				
TOTAL	24	502	15	322	9	160

In March, 8 branches per ramet were tagged with aluminum tags (numbered 1-8) and orange flagging. The number of female flowers and 2nd year cones found on each tagged branch were recorded. These tagged branches were resampled in April, July, August, and September to obtain survival estimates.

II. Assessment of Key Pest Populations

The Erambert Seed Orchard contains loblolly, slash, longleaf, and shortleaf seed sources. While many of the insect pests feed as generalists on several pine species, a few pests prefer only one particular species. The following are key insect pests causing flower, conelet, and cone damage to the Alabama loblolly seed source.

<u>Leptoglossus corculus</u> (Say)	Leaffooted pine seedbug
<u>Tetyra bipunctata</u> (H.-S.)	Shieldbacked pine seedbug
<u>Dioryctria merkeli</u> Mutuura & Munroe	Loblolly pine coneworm
<u>Dioryctria amatella</u> (Hulst)	Southern pine coneworm
<u>Dioryctria clarioralis</u> (Walker)	Blister coneworm
<u>Dioryctria disclusa</u> Heinrich	Webbing coneworm
Family Cecidomyiidae	Cone feeding midges

Currently there are no techniques to predict population trends for any of these pests. A few techniques are available to detect the presence of certain pests.

A. Pheromone trapping for Dioryctria spp.

Pheromone trapping techniques are available for 4 coneworm species, D. disclusa, D. clarioralis, D. merkeli, and D. amatella. Dioryctria disclusa, D. clarioralis, and D. merkeli are attracted to one pheromone while D. amatella is attracted to a different pheromone. Because pheromone trapping for these species is a relatively new technique, a standardized trapping scheme has not been developed. In the interim, Forest Service Research recommended using 10 Pherocon 1C® traps baited with each pheromone. Traps were hung with a pulley system from an upper limb located within the top 10 feet of the crown. Twice a week orchard personnel checked the traps and recorded the number of male moths caught. Baits were changed monthly.

B. Visual searches for Leptoglossus corculus and Tetyra bipunctata

Attractive trapping methods are not available for either species of seedbug commonly found in seed orchards. Beginning in late March, visual searches were made of all branches sampled as part of the cone and seed inventory-monitoring system. The number of seedbugs sighted was recorded.

III. Assessment of Impact Caused by Key Pests

Data were gathered, which were used to generate impact estimates, by identifying causes of mortality for cones and conelets inventoried in the cone and seed inventory-monitoring system.

RESULTS AND DISCUSSION

I. Assessment of Crop Production Levels

Based upon data from the cone and seed inventory-monitoring system, approximately 1,460 bushels of the 1983 loblolly cone crop were estimated to be present in the Alabama loblolly seed source as of September 1983. This represents the survival of 64% of the potential cone crop estimated in March 1982. In addition, 3,451 bushels of cones of the potential 1984 crop are currently on the trees. This estimate represents the survival of 69% of the potential cone crop estimated in March 1983. Predictions based on a generalized survival curve indicate that approximately 2,446 bushels of Alabama loblolly cones should be harvested in October 1984. Tables 2 and 3 summarize these predictions for the 1983 and 1984 crops, respectively.

The following were assumed in predicting the size of the 1983 and 1984 cone crops.

1. Sample ramets are representative of all of the ramets of the selected clones.
2. Selected clones represent production levels of unsampled clones.
3. One bushel contains 300 cones.
4. One pound of seed can be extracted from a bushel of cones.
5. Potential estimates are based on the survival of 100% of the flowers or cones from each visit until harvest.
6. Predicted estimates are based on a generalized curve which predicts the crop size expected at maturity when additional mortality occurs (Bramlett).

The orchard production, in bushels of cones for the 1983 and 1984 cone crops, is illustrated in figures 1A and 1B. The solid line on each graph represents the generalized curve compiled by Bramlett and Godbee (1982) for cone survival in a moderately managed loblolly orchard. The dashed lines represent the actual cone survival based upon periodic observations of tagged branches.

Table 2. Estimation, based on the inventory-monitoring system, of 1983 Alabama loblolly pine cone crop.

Date	No. Cones	Bushels of Cones	Lbs. of Seed
March 1982			
Potential	686,566	2,289	2,289
Predicted	411,940	1,373	1,373
April 1982			
Potential	535,456	1,785	1,785
Predicted	295,223	984	984
June 1982			
Potential	525,119	1,750	1,750
Predicted	315,820	1,053	1,053
July 1982			
Potential	517,757	1,726	1,726
Predicted	343,283	1,144	1,144
August 1982			
Potential	513,058	1,710	1,710
Predicted	357,014	1,190	1,190
March 1983			
Potential	497,895	1,660	1,660
Predicted	398,208	1,327	1,327
July 1983			
Potential	458,725	1,529	1,529
Predicted	391,343	1,304	1,304
August 1983			
Potential	450,479	1,502	1,502
Predicted	418,802	1,396	1,396
September 1983			
Potential	438,094	1,460	1,460
Predicted	438,094	1,460	1,460

Table 3. Estimation, based on the inventory-monitoring system, of 1984 Alabama loblolly cone crop.

Date	No. Cones	Bushels of Cones	Lbs. of Seed
March 1983			
Potential	1,497,370	4,991	4,991
Predicted	898,422	2,995	2,995
April 1983			
Potential	1,495,723	4,986	4,986
Predicted	973,290	3,244	3,244
July 1983			
Potential	1,059,825	3,533	3,533
Predicted	688,790	2,296	2,296
August 1983			
Potential	1,056,046	3,520	3,520
Predicted	718,738	2,396	2,396
September 1983			
Potential	1,035,394	3,451	3,451
Predicted	733,711	2,446	2,446

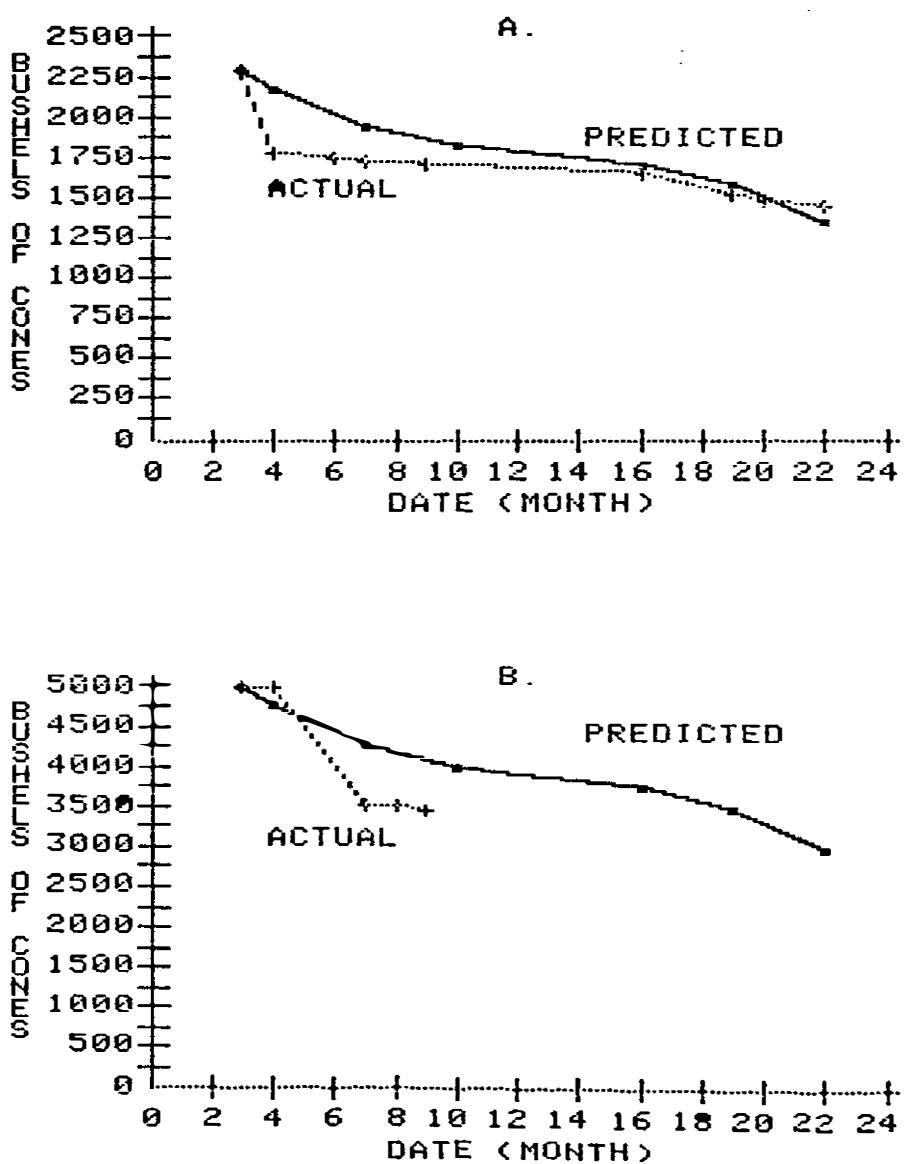


Figure 1. Survival curves for the 1983 cone crop (1A) and the 1984 cone crop (1B) estimated from the cone and seed inventory-monitoring system.

II. Assessment of Key Pest Populations

Cneworm species - Dioryctria amatella - Southern Pine Coneworm
- D. clarioralis - Blister Coneworm
- D. disclusa - Webbing Coneworm
- D. merkeli - Loblolly Pine Coneworm

Biology

- In the western zone of the Southern Region, greatest losses due to coneworms have been attributed to D. amatella (DA) and D. clarioralis (DC). These pests have multiple generations per year and, therefore, the potential exists for population buildup during the season.

Dioryctria amatella overwinters as an early instar larva and begins feeding on male and female flower buds. Later these larvae migrate to 2nd year cones where they pupate and emerge. Damage from the overwintering generation should occur prior to the first flight which usually begins in mid-April. The damage on 2nd year cones consists of dead or dying cones with entry holes surrounded but not enclosed by pitch and frass masses. The adult flights are not discrete. The pheromone traps capture moths in low numbers throughout the season.

Dioryctria clarioralis overwinters as a large larva and does little or no damage prior to the first adult flight in the spring (May). Three generations occur across most of the South. The larvae infest flowers, shoots, buds and young cones. The infested material is hollowed out and a distinctive blister of pitch-coated webbing covers the entry hole.

Two single generation pests, D. disclusa (DD) and D. merkeli (DM), are receiving considerable attention throughout the Southern Region. Dioryctria disclusa has caused heavy losses in certain orchards within the eastern zone. Pheromone trap catches indicate that the impact from D. merkeli may be more than previously expected.

Shoot attacks, particularly in slash pine, may be the earliest visible coneworm damage found during the spring. These attacks are usually attributed to D. merkeli. After overwintering as small larvae they move from shoots and flowers to

cones. These cones die prior to elongation without any evidence of external webbing. The larvae remain inactive throughout the summer, pupating and emerging in the fall. The adult flight usually begins in September and continues throughout October.

Dioryctria disclusa overwinters as a small larva and can be found in the male catkins in the spring. If populations are large, webbing becomes very noticeable within the catkins. When the catkins are dry the larvae migrate to 2nd year cones, often before control programs have begun. The cones die prior to elongation, and webbing and frass are present surrounding the entry hole.

Pest Status

- Figure 2 is a graph of the 1983 pheromone data which Erambert personnel provided to George Ryan, Statistician, USDA-FS, Region 8, Atlanta, GA. The total trap catch (y-axis) is the sum of all males caught in the traps baited during the trapping interval. The trapping intervals have been expressed on a monthly scale. Table 4 is a ranking chart which ranks each orchard according to the total number of each species captured throughout the summer. The orchard and the total trap catch of each species has been high-lighted in 1 of 3 colors. These colors represent the following arbitrarily established potential loss classes: High (blue), >100 moths; moderate (green), 10-100 moths; and low (yellow), <10 moths. Data were received from 64 orchards. Orchards which reported "0 catches" were not ranked. The rank within the southeast for each species can be determined by following the high-highlighted line to the left hand column.

The pest status and approximate dates of the adult flights for the 4 Dioryctria spp. have been summarized in table 5.

Seedbug Species

- Leptoglossus corculus (Say) - leaffooted pine seedbug
- Tetyra bipunctata (H.-S.) - shieldbacked pine seedbug

Biology

- The sizes of seedbug populations vary widely among seed orchards. Populations of leaffooted pine seedbugs are considered to be more

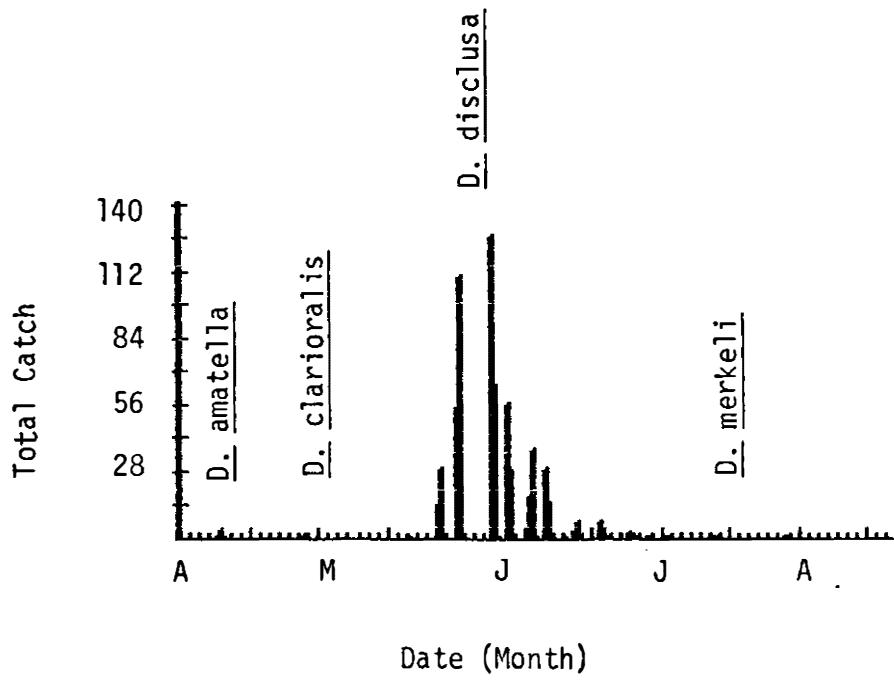


Figure 2. Frequency histogram of the pheromone trap catches of 4 coneworm species (1983)

Table 4. Orchard rankings by total moth catch of four Dioryctria spp. included in the 1983 pheromone survey (March-August). High-lighted colors represent the following arbitrarily established potential loss classes: High (blue), >100 moths; moderate (green), 10-100 moths; and low (yellow), <10 moths.

Rank	Orch.	No. of DC	Orch.	No. of DD	Orch.	No. of DM	Orch.	No. of DA
1	112	88	108	415	36	50	105	80
2	13	76	107	333	18	33	112	58
3	109	45	17	297	23	24	18	50
4	20	36	18	288	106	15	125	47
5	105	30	103	118	107	13	7	38
16	122	28	119	99	19	12	20	35
17	7	25	30	82	16	6	122	33
18	101	10	28	64	26	3	110	31
19	125	9	19	60	34	3	36	29
10	18	8	13	59	10	2	106	28
11	36	6	106	58	14	2	13	26
12	4	5	116	51	35	2	27	25
13	102	5	16	47	101	2	117	25
14	119	5	39	46	13	1	9	22
15	19	4	14	36	31	1	104	22
26	45	4	20	27	37	1	119	21
27	106	4	112	23	103	1	101	17
28	10	3	9	12	108	1	113	14
29	24	3	35	9	112	1	1	12
20	26	3	110	9	113	1	14	12
21	28	3	117	8	122	1	17	11
22	103	3	1	7			35	11
23	108	3	31	7			102	9
24	110	3	109	7			16	8
25	115	3	25	5			103	8
36	118	3	26	5			109	8
37	35	2	101	4			11	7
38	38	2	105	4			25	7
39	14	1	37	3			4	5
30	16	1	102	3			37	5
31	17	1	114	3			29	4
32	27	1	115	3			10	3
33	41	1	4	2			38	3
34	116	1	23	2			108	3
35			29	2			19	2
46			41	2			28	2
47			125	2			39	2
48			11	1			42	2
49			42	1			107	2
40							116	2
41							2	1
42							12	1
43							23	1
44							121	1

Table 5. Pest status and approximate dates of major Dioryctria spp.

Pest	Status	Dates of Peak Flights
D. <u>disclusa</u>	High	Early June
D. <u>merkeli</u>	Unknown	Late September - Early October
D. <u>clarioralis</u>	Moderate	Early May
D. <u>amatella</u>	Moderate	Sporadic throughout the summer beginning late April

destructive than populations of shieldbacked pine seedbugs.

Both species overwinter as adults. In the spring L. corculus and T. bipunctata adults feed primarily on conelets. Apparently L. corculus adults mate and produce a new brood during spring and early summer. This generation is followed by another overlapping brood in July and August. Tetyra bipunctata eggs are seldom found prior to mid-July, indicating that the overwintering adults have produced their first brood. This brood matures resulting in the familiar increase in numbers found at harvest.

Pest Status

- Prior to the September evaluation few seedbugs were sighted. During the September evaluation T. bipunctata was the more numerous species. Based on the numbers sighted, little damage should have occurred in 1983.

III. Assessment of Impact Caused by Key Pests

The greatest cone and conelet losses occurred between early April and early July, 1983. During this period 8.26% of the cones (137 bushels) and 29.81% of the conelets (1,494 bushels) were damaged, destroyed, or missing. Coneworms caused more mortality or damage of 2nd year cones (5.87%) than any other identifiable mortality agent. As indicated by the results of the 1982 and 1983 pheromone survey, the Dioryctria spp. trapped in greatest numbers were D. disclusa and D. merkeli. Both of these pests cause early season loss similar to those found at the Erambert. Approximately 26% of the conelets present in early April were missing during the early July evaluation. This loss represents the combined effects of seedbug feeding, physiological abortion, inadequate pollination, disease, sampling error, etc. Tables 6 and 7 summarize these data.

RECOMMENDATIONS

With an effective pest management program, the 1984 cone crop should be another excellent crop. Six pest management alternatives are presented in Appendix I. In 1982 and 1983 D. disclusa and D. merkeli were the key pests of 2nd year cones. Assuming that the same species causing damage in 1983 continue to cause losses in 1984, FPM recommends that the 1984 pest management strategy should consist of a series of pesticide applications (see Appendix I, Alternative 6) applied via aircraft. Figure 3 illustrates the suggested spray schedule and the target pest species. Pest species are high-lighted in the following colors: Blue - adult flights of D. clarioralis; green - adult flights of D. amatella; yellow - adult flights of D. merkeli and D. disclusa, and major damage periods for both species; pink - slash pine flower thrips, adult flight of first generation tip moth, and adult flights of L. corculus and T. bipunctata.

Table 6. Summary of cone mortality of the 1983 Alabama loblolly pine crop.

Mortality Agents	No. of Dead Cones	% Mortality ^{1/}
March - April 1983		
Coneworms	3,460	0.67
Unknown	549	0.11
Unknown Damage	145	0.03
Unknown Insects	274	0.05
Missing	5,407	1.05
TOTAL	9,835	1.91
April - July 1983		
Coneworms	29,249	5.87
Coneworm Damage ^{2/}	4,944	0.99
Unknown	4,804	0.96
Unknown Damage	1,113	0.22
Missing	3,780	0.76
Pitch Canker	311	0.06
Broken or Dead Branches	1,955	0.39
TOTAL	41,212	8.26
July - August 1983		
Coneworms	6,813	1.49
Coneworm Damage ^{2/}	3,632	0.79
Missing	1,281	0.28
Broken or Dead Branches	1,181	0.26
TOTAL	9,275	2.03
August - September 1983		
Coneworms	7,056	1.57
Coneworm Damage ^{2/}	4,042	0.90
Unknown	1,572	0.35
Unknown Damage	1,029	0.23
Unknown Insect	139	0.03
Missing	1,988	0.44
Broken or Dead Branches	313	0.07
TOTAL	12,097	2.69

^{1/} % mortality was calculated based upon the number of cones alive at the beginning of each evaluation interval.

^{2/} Coneworm damage is included under the coneworm heading.

Table 7. Summary of conelet mortality of the 1984 Alabama loblolly pine cone crop.

Mortality Agents	No. of Dead Conelets	% Mortality ^{1/}
March - April 1983		
Unknown	1,360	0.09
Unknown Insect	120	0.01
TOTAL	1,480	0.10
April - July 1983		
Missing	385,424	25.77
Unknown	25,233	1.69
Unknown Insect	1,249	0.08
Unknown Insect Damage	2,267	0.15
Pitch Canker	31,857	2.13
Broken or Dead Branch	1,890	0.13
Coneworms	168	0.01
TOTAL	448,088	29.96
July - August 1983		
Missing	7,915	0.75
Unknown	2,245	0.21
Unknown Insect	372	0.04
Broken or Dead Branch	6,447	0.61
TOTAL	16,979	1.61
August - September 1983		
Missing	10,657	1.01
Unknown	1,855	0.18
Unknown Insect	457	0.04
Broken or Dead Branch	6,545	0.62
Coneworms	2,530	0.24
TOTAL	22,044	2.09

^{1/} % mortality was calculated based upon the number of conelets alive at the beginning of each evaluation interval.

Figure 3. Suggested pest management spray schedule for the Erambert Seed Orchard (1984).

Suggested Spray Dates																				
Month	January				February				March				April							
Days	1-7	8-14	15-21	22-28	29-31	1-7	8-14	15-21	22-28	1-7	8-14	15-21	22-28	1-7	8-14	15-21	22-28	29-31		
D°	5	15	20	63		55	100	120	165	205	270	335	410	480	520	595	700	830		
LOBLOLLY																				
SLASH	Stash Pine flower tips																			
LONGLEAF																				
SHORTLEAF																				
Month	May				June				July				August							
Days	1-7	8-14	15-21	22-28	29-31	1-7	8-14	15-21	22-28	29-31	1-7	8-14	15-21	22-28	29-31	1-7	8-14	15-21	22-28	29-31
D°	1030	1170	1340	1505	1690	1765	1955	2150	2375	2530	2635	2845	3060	3250	3500	3590	3800	4020	4235	4450
LOBLOLLY	Eggs	Damage				D. clarioralis					Eggs	Damage				D. amatella				Eggs
SLASH	Eggs	Damage				D. clarioralis					Eggs	Damage				D. amatella				Eggs
LONGLEAF	Eggs	Damage				D. clarioralis					Eggs	Damage				D. amatella				Eggs
SHORTLEAF	Eggs	Damage				D. clarioralis					Eggs	Damage				D. amatella				Eggs
Month	September				October				November				December							
Days	1-7	8-14	15-21	22-28	29-31	1-7	8-14	15-21	22-28	29-31	1-7	8-14	15-21	22-28	29-30	1-7	8-14	15-21	22-28	29-31
D°	4535	4740	4945	5135	5330	5375	5515	5655	5775	5835	5935	6010	6075	6110	6145	6150	6175	6210	6240	6260
LOBLOLLY	D. clarioralis	Eggs	Damage			D. amatella	Eggs									D. clarioralis	Eggs	Damage		
SLASH	D. clarioralis	Eggs	Damage			D. amatella	Eggs									D. clarioralis	Eggs	Damage		
LONGLEAF	D. clarioralis	Eggs	Damage			D. amatella	Eggs									D. clarioralis	Eggs	Damage		
SHORTLEAF	D. clarioralis	Eggs	Damage			D. amatella	Eggs									D. clarioralis	Eggs	Damage		

The following calendar is the suggested spray schedule.

<u>Application</u>	<u>Date</u>	<u>Pesticide</u>	<u>Species</u>
1	6 days after peak pollen shed	Guthion®	All
2	2 weeks after appl. #1	Pydrin®	All
3	1st week in May	Guthion	All
4	2nd week in July	Guthion	All
5	3rd week in August	Guthion	Slash
6	3rd week in September	Pydrin	All except slash

Pydrin should be applied by aircraft at a rate of .75 lbs of active ingredient per acre. This chemical is more suitable for applications during the season when the probability of rainfall is greatest and when orchard personnel are likely to be in the orchard for prolonged periods. The Guthion applications should be applied by aircraft at a rate of 2 lbs of active ingredient per acre.

Suggested application parameters for fixed-wing and helicopter are listed below.

<u>Parameter</u>	<u>Helicopter</u>	<u>Fixed Wing</u>
Droplet size VMD (microns)	300-350	300-350
Nozzles	50 (D-02-25)	30 (D-06-46)
Boom Pressure (PSIG)	40	40
Speed (MPH)	25	90
Swath Width (ft.)	30 or 60	30 or 60
Release height above trees (ft.)	5	5
Adjuvant - Nalco-Trol®	3 oz/100 gal H ₂ O	3 oz/100 gal H ₂ O

Our experience has shown that many aerial applicators can apply the insecticide with a 60 ft. swath. We have no reason to suspect that an increase in swath width should adversely affect the coverage. With aerial application approximately 1/3 to 1/2 the active ingredient is applied as compared to a mistblower. The savings in chemicals could help defray additional application costs.

If the Erambert Orchard finds that Alternative 6 with aerial application does not meet their needs, FPM recommends the following alternatives in the order listed.

- 1) Alternative 4 - Aerial application
- 2) Alternative 4 - Ground application
- 3) Alternative 5 - Aerial application

Appendix I describes suggested control alternatives.

REFERENCES

- Barber, L. R. An evaluation of insect damage in three southern federal seed orchards (1982). Rep. No. SA 82-1-21. Asheville, NC: U.S. Department of Agriculture, Forest Service, Forest Pest Management; 1982.
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APPENDIX I

SEED ORCHARD PEST MANAGEMENT CONTROL ALTERNATIVES

Alternative 1. No action.

Benefits:

- 1) Lowers management costs
- 2) Encourages the natural buildup of beneficial insects and other predators
- 3) Reduces exposure of personnel to pesticides
- 4) Discourages the development of resistant strains of pests

Detriment:

- 1) Losses must be tolerated for indefinite periods of time
- 2) Pest populations may build to levels which cannot be tolerated before beneficial insects check the increase

Rationale: This alternative is usually selected when the value of the existing crop is less than the cost of the most inexpensive chemical control measure. As second generation orchards begin producing and as superior seed becomes available in storage, 1st generation orchards, or blocks within these orchards, may be placed on low maintenance. Under a low maintenance program, the "No Action" alternative will become an integral component.

Currently this option is of limited value. Young orchards which have not experienced pest population buildups are probably more efficiently managed without a structured spray program. Very few managers of producing orchards consider this a viable alternative.

Alternative 2. One Furadan® application.

Benefits:

- 1) Targeted at pests which feed on pine, not at beneficial insects
- 2) One application may reduce pest populations for several months

Detriments:

- 1) Furadan 15G has a high oral toxicity and must be incorporated into soil
- 2) High cost for a single application
- 3) Translocation is dependent upon adequate soil moisture
- 4) Efficacy decreases by midsummer
- 5) Application must be made in late winter or early spring when the ground is frozen or wet

Rationale: This alternative is usually considered for fairly well-drained orchards. Many orchards across the Southeast are too wet in late winter, and the application must be delayed. Applications made after mid-February will not effectively control early season pests. Apparently Furadan provides better protection of conelet crops than it does cone crops. If the flower crop is the featured crop, then a single Furadan application may be an effective strategy.

Orchard managers who have chosen this single application strategy must be willing to accept late season losses.

Alternative 3. Split Furadan application.

Benefits:

- 1) Targeted at pests which feed on pine, not at beneficial insects
- 2) One application may reduce pest populations for several months
- 3) Allows for flexibility in determining when Furadan will be effective

Detriments:

- 1) Furadan 15G has a high oral toxicity and must be incorporated into soil
- 2) High application and chemical cost
- 3) Translocation is dependent upon adequate soil moisture
- 4) Applications may be delayed because of ground conditions

Rationale: This alternative is usually considered in the same orchard where a single Furadan application would be effective. The treatments should be made approximately 6 weeks before the targeted pests are active or before the previous Furadan concentrations have dropped below the lethal concentration (LC). This alternative may allow you to extend the protection associated with Furadan throughout the growing season. In theory, this alternative has potential. However, the inconsistencies associated with Furadan uptake and

translocation probably will make the double application even more inconsistent.

Timing is an important consideration. If the first application is targeted for early season pests, then the standard mid-February application will probably be timely for this first application. Furadan usually dissipates by mid to late summer. Therefore, a second application should be applied in late May or early June.

The 2nd important consideration is the application rate. The current label allows for application of from 2.7 - 5.3 oz. of Furadan 15G for each inch of tree diameter. In a split application, two 2.7 oz. applications should be effective if uptake is sufficient.

Preliminary results indicate that split applications of Furadan used alone do not adequately increase protection over a single application (Overgaard 1976). Additional modifications could be considered but the most important consideration is the benefit:cost of 2 applications as opposed to a single application.

Alternative 4. Three to six sprays of Guthion® or Pydrin®.

Benefits:

- 1) Multiple sprays allow flexibility in timing applications
- 2) Frequency of applications can reflect insect damages and/or population levels
- 3) Flexibility in method of application (ground, air)

Detriments:

- 1) Labor intensive
- 2) Excessive exposure of personnel to restricted use pesticide
- 3) Ground applications may be delayed by excessive soil moisture
- 4) Residuals from foliar applications are affected by rainfall

Rationale: This alternative allows more responsiveness to insect population levels and flexibility in targeting an application to coincide with the life cycle of the pests. Guthion and Pydrin are the only chemicals currently registered for coneworm control which can be applied monthly, throughout the summer, at the recommended rates.

The most widely used formulation of Guthion is the 2S formulation. The 2S formulation does not crystalize when

stored below freezing. In addition, the 2S formulation as compared with the WP formulation can be applied with less wear to spraying equipment. However, the WP formulation has a longer residual than the 2S formulation. It may be advantageous to utilize the advantages of each formulation and use the WP formulation in spring when rainfall is heavy; switching to the less abrasive formulation in the summer and fall.

Pydrin is a synthetic pyrethroid with a low mammalian toxicity. Exposure of orchard personnel to Pydrin is much less hazardous than exposure to Guthion. In addition, Pydrin remains at effective concentration for longer periods than Guthion 2S.

The application schedule is extremely important. Applications should be made just prior to the periods when the greatest damages occur. The first spring application usually is made during the week following pollination. This application coincides well with the period when major conelet losses occur and when early coneworm caused losses are beginning. Subsequent sprays are often applied at monthly intervals following the initial spray. If the orchard manager has adequate information to identify and monitor the key pests, then the applications can be targeted for the susceptible stages of the key pests. Currently the technology to monitor and time sprays is limited.

Alternative 5. Furadan combined with supplementary sprays.

Benefits:

- 1) Insures the orchard is protected during the entire season
- 2) Increases the suppression efforts against coneworms
- 3) Early spray applications serve as a backup to Furadan if uptake is minimal

Detriments:

- 1) Furadan 15G has a high oral toxicity and must be incorporated into soil
- 2) Translocation is dependent upon adequate soil moisture
- 3) Application must be made in late winter or early spring when the ground is frozen or wet
- 4) Labor intensive
- 5) Ground applications may be delayed by excessive soil moisture
- 6) Pest management costs are increased substantially
- 7) Residuals from foliar applications are affected by rainfall

Rationale: This alternative is becoming increasingly popular with industrial orchards. Often the size of the area to be treated is the limiting factor.

If Furadan uptake is sufficient, conelet survival is increased substantially. The highest Furadan concentrations are usually found in the actively growing shoots, making Furadan an ideal pesticide for early season shoot infesting pests such as tip moths. Furadan appears to be less effective against coneworms, damaging 2nd year cones. Therefore, backup sprays increase the suppression efforts targeted for coneworm control. Both pesticides are usually effective against seedbugs.

The major concern when choosing this alternative is timing the supplementary sprays to obtain maximum protection for the increased management costs. If the orchard has a history of early season pests, particularly 1st generation coneworms (Dioryctria disclusa, etc.), it may be desirable to apply a pesticide 6 days after peak pollen flight. Beginning in mid-May or early June, 2 to 4 additional sprays should protect 2nd year cones against increasing coneworm populations. If cones are harvested using the traditional hand picking procedures, the last spray would probably be applied 2 or 3 weeks before harvest. If netting is used to harvest seed, the last spray can be delayed to suppress increasing populations of both seedbugs and coneworms.

The choice of insecticides is limited. Currently 2 insecticides, Pydrin and Guthion, are registered for coneworm and seedbug control. Pydrin is an ideal chemical for spray applications during periods when orchard personnel are active within the orchard and during periods when a longer residual is needed. Therefore, spring and fall would be ideal times for Pydrin applications while Guthion might be applied in midsummer. This combination of insecticides, Furadan, Guthion, and Pydrin, should help eliminate many of the sucking insect problems associated with the use of Pydrin and Guthion applied by aerial application.

Alternative 6. Three to six sprays of mixed chemicals.

Benefits:

- 1) Multiple sprays allow flexibility in timing applications
- 2) Frequency of applications can reflect insect damages and/or population levels
- 3) Flexibility in method of application (ground, air)
- 4) Decreased potential for resistant pest populations
- 5) Less exposure to highly toxic chemicals

Detriments:

- 1) Labor intensive
- 2) Excessive exposure of personnel to restricted use pesticide
- 3) Ground application may be delayed by excessive soil moisture
- 4) Residuals from foliar applications are affected by rainfall

Rationale: This alternative is very similar to Alternative 4. It is usually advantageous to alternate chemicals rather than to depend on one chemical. Alternate applications of chemicals, with different modes of actions, tend to decrease the development of resistant pest populations. Currently, Pydrin and Guthion are the two registered chemicals which fit well into a spray schedule. Hydraulic, mist blower, and aerial applications of both chemicals have been demonstrated to effectively suppress coneworm and seedbug populations. The characteristics of each chemical have been described under the rationale section of Alternative 4. These characteristics should help determine when each chemical should be applied.

PRECAUTIONARY STATEMENT

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in their original containers under lock and key out of reach of children and animals, and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear appropriate protective clothing.

If your hands become contaminated with a pesticide, wash them immediately with soap and water. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove the clothing immediately and wash skin thoroughly. After handling or spraying pesticides, do not eat or drink until you have washed with soap and water.

Do not clean spray equipment or dump excess spray material near ponds, streams, or wells. Because it is difficult to remove all traces of herbicide from equipment, do not use the same equipment for insecticides or fungicides that you used for herbicides.

Dispose of empty pesticide containers promptly. Have them buried at a sanitary landfill dump, or crush and bury them in a level, isolated place.

NOTE: Some states have restrictions on the use of certain pesticides. Check your state and local regulations. Also, because registrations of pesticides are under constant review by the U.S. Environmental Protection Agency, consult your county agent, state extension specialist or FPM to be sure it is still registered for the intended use. For further information or assistance, contact Forest Pest Management, Alexandria Field Office, Pineville, La., 71360, (Telephone: FTS 497-7280, or Commercial 318/473-7280).

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BIOLOGICAL EVALUATION OF INSECT
DAMAGE AT THE ERAMBERT SEED ORCHARD,
NATIONAL FORESTS IN MISSISSIPPI (1983)

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